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The Current State of 3D and 4D Imaging in Diagnostic Radiology

The most common 3D visualization applications in clinical diagnostic radiology now are cardiac and colon, but the technology is often used in vascular, orthopedics, craniofacial deformities, thoracic, and many other areas. In the past, dedicated workstations and highly skilled operators were required to produce CT or MR angiograms, body region or organ surface views, and analysis products. Many centers have dedicated technologists who work in a “3D lab” to extract vessel trees, disarticulate limbs, synthesize transparencies and cine sequences. These services are now reimbursed by 3rd party payors, and almost all CT & MRI scanners today have integrated post-processing tools. Since generation of advanced visualizations is not a good use of scanner console time if the process cannot be accomplished unattended in a short time, new enterprise systems has been introduced that allow thin clients located anywhere to employ software tools and generate custom views interactively. In the surgeon’s office, at the oncology clinic, or even in the operating room, it is now feasible to manipulate 3D image data sets. Very specialized tools for white matter tractography, MR spectroscopic imaging, functional MRI, and myocardial perfusion are examples of new software agents tailored to subspecialty requirements. Several vendors provide post-processing services for prosthesis or implant custom sizing and design, based on 3D image data sets, where the advanced visualization images are quantified and synthesized in their facilities.

4D imaging and higher dimensions are increasingly common, since almost all cardiac CT and MRI examinations require them. Whole organ and body region perfusion, in the brain and elsewhere employ 4D methods. Multimodality and multitemporal data sets, as well as multispectral (e.g., dual energy 3D data, for example) are acquired and analyzed with software tools that focus on specific clinical issues in neuroradiology and cardiothoracic practice.

So, the most important current trends involve routinely collecting 3D and 4D data sets which are intended for more than simple subjective image review, but are destined to be post-processed and analyzed with enterprise software tools on thin clients, so immediate results can be obtained that are tailored to subspecialty needs.

Educational objectives:

1. To understand the sources of 3D and 4D images in clinical diagnostic radiology, including the data acquisition systems and protocols
2. To learn how advanced visualization and image analysis are evolving from dedicated workstations to enterprise software applications.
3. To see how subspecialized software tools for highly specific imaging applications are used in clinical radiology
4. To explain 4D datasets are used for cardiac and neuroimaging, where the image analysis results are often quantitative rather than morphologic.